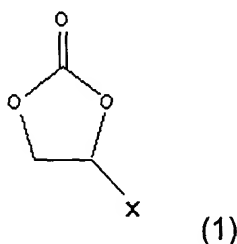


CLAIMS

What is claimed is:

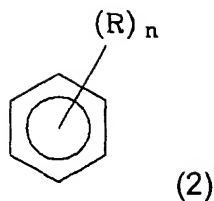
1. An electrolyte of a lithium secondary battery comprising:
lithium salts;
an organic solvent with a high boiling point; and
a carbonate-based additive compound having substituents selected from the group consisting of a halogen, a cyano (CN), and a nitro (NO₂).
2. The electrolyte of a lithium secondary battery according to claim 1, wherein the carbonate-based additive compound is a cyclic carbonate.
3. The electrolyte of a lithium secondary battery according to claim 1, wherein the carbonate-based additive compound is a carbonate represented by formula (1):



wherein X is selected from the group consisting of a halogen, a cyano (CN), and a nitro (NO₂).

4. The electrolyte of a lithium secondary battery according to claim 1, wherein the carbonate-based additive compound is fluoroethylene carbonate.
5. The electrolyte of a lithium secondary battery according to claim 1, wherein the carbonate-based additive compound is added in an amount of 0.01 to 10 wt%.
6. The electrolyte of a lithium secondary battery according to claim 5, wherein the carbonate-based additive compound is added in an amount of 0.01 to 5 wt% based on the total amount of the electrolyte.

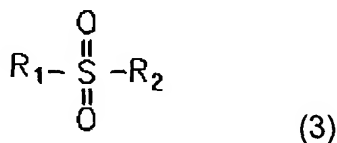
7. The electrolyte of a lithium secondary battery according to claim 1, wherein the lithium salts are at least one selected from the group consisting of LiPF_6 , LiBF_4 , LiSbF_6 , LiAsF_6 , LiClO_4 , LiCF_3SO_3 , $\text{Li}(\text{CF}_3\text{SO}_2)_2\text{N}$, $\text{LiC}_4\text{F}_9\text{SO}_3$, LiSbF_6 , LiAlO_4 , LiAlCl_4 , $\text{LiN}(\text{C}_x\text{F}_{2x+1}\text{SO}_2)(\text{C}_y\text{F}_{2y+1}\text{SO}_2)$ (where x and y are natural numbers), LiCl , and LiI .
8. The electrolyte of a lithium secondary battery according to claim 7, wherein the lithium salts are used in a concentration ranging from 0.6 to 2.0 M.
9. The electrolyte of a lithium secondary battery according to claim 1, wherein the organic solvent with a high boiling point has a boiling point of more than or equal to 100°C .
10. The electrolyte of a lithium secondary battery according to claim 9, wherein the organic solvent with a high boiling point has a boiling point of more than or equal to 150°C .
11. The electrolyte of a lithium secondary battery according to claim 10, wherein the organic solvent with a high boiling point has a boiling point of more than or equal to 200°C .
12. The electrolyte of a lithium secondary battery according to claim 1, wherein the organic solvent with a high boiling point is selected from the group consisting of γ -butyrolactone, ethylene carbonate, dipropyl carbonate, acid anhydride, N-methyl pyrrolidone, N-methylacetamide, N-methyl formamide, acetonitrile, dimethyl formamide, sulforane, dimethyl sulfoxide, dimethyl sulfite, and a mixture thereof.
13. The electrolyte of a lithium secondary battery according to claim 1, wherein the electrolyte further comprises an organic solvent with a low boiling point.
14. The electrolyte of a lithium secondary battery according to claim 13, wherein the organic solvent with a low boiling point is selected from the group consisting of dimethyl carbonate (DMC), diethyl carbonate (DEC), methylpropyl carbonate (MPC), ethylpropyl carbonate (EPC), methylethyl carbonate (MEC), propylene carbonate (PC), butylene carbonate (BC), and a mixture thereof.
15. The electrolyte of a lithium secondary battery according to claim 1, wherein the electrolyte further comprises an aromatic hydrocarbon organic solvent of formula (2):



wherein R is a halogen or a C₁ to C₁₀ alkyl, and n is an integer of 0 to 6.

16. The electrolyte of a lithium secondary battery according to claim 15, wherein the aromatic hydrocarbon organic solvent is selected from the group consisting of benzene, fluorobenzene, toluene, fluorotoluene, trifluorotoluene, xylene, and a mixture thereof.

17. The electrolyte of a lithium secondary battery according to claim 1, wherein the electrolyte further comprises an organic sulfone-based compound of formula (3):



wherein R₁ and R₂ are independently selected from the group consisting of a primary, secondary or tertiary alkyl group, an alkenyl group, an aryl group, and a cycloalkyl group, or R₁ and R₂ are bound together to form a cyclic ring.

18. The electrolyte of a lithium secondary battery according to claim 17, wherein R₁ and R₂ are independently selected from the group consisting of a C₁ to C₄ alkyl, a C₂ to C₄ alkenyl, a C₆ to C₁₄ aryl, and a C₃ to C₆ cycloalkyl.

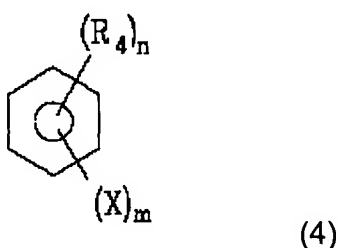
19. The electrolyte of a lithium secondary battery according to claim 17, wherein R₁ and R₂ are independently a halogen-substituted alkyl group, an alkenyl group, an aryl group, or a cycloalkyl group.

20. The electrolyte of a lithium secondary battery according to claim 17, wherein the sulfone-based compound is selected from the group consisting of vinyl sulfone, methyl sulfone, methylvinyl sulfone, ethylvinyl sulfone, phenyl sulfone, phenylvinyl sulfone, chlorophenylvinyl sulfone, fluorophenylvinyl sulfone, benzyl sulfone, tetramethylene sulfone, butadiene sulfone, and a mixture thereof.

21. The electrolyte of a lithium secondary battery according to claim 17, wherein the sulfone-based compound is added in an amount of 0.01 to 10 wt% based on the total amount of the electrolyte.

22. The electrolyte of a lithium secondary battery according to claim 21, wherein the sulfone-based compound is added in an amount of 0.01 to 6 wt% based on the total amount of the electrolyte.

23. The electrolyte of a lithium secondary battery according to claim 1, wherein the electrolyte further comprises a compound of formula (4):



wherein R_4 is a C_1 to C_{10} alkyl, a C_1 to C_{10} alkoxy, or a C_6 to C_{10} aryl, X is a halogen, and m and n are integers ranging from 1 to 5, where $m+n$ is less than or equal to 6.

24. The electrolyte of a lithium battery according to claim 23, wherein the compound of formula (4) is a compound selected from the group consisting of 3-fluoroanisole, 3-chloroanisole, 3-bromoanisole, 4-fluoroanisole, 4-chloroanisole, 4-bromoanisole, 2,4-difluoroanisole, 3,5-difluoroanisole, 3-chloro-5-fluoroanisole, and a mixture thereof.

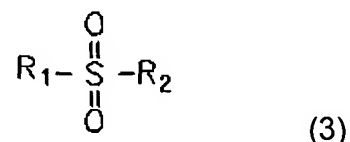
25. The electrolyte of a lithium secondary battery according to claim 23, wherein the compound of formula (4) is added in an amount of 0.01 to 10 wt% based on the total amount of the electrolyte.

26. The electrolyte of a lithium secondary battery according to claim 25, wherein the compound of formula (4) is added in an amount of 0.01 to 6 wt% based on the total amount of the electrolyte.

27. The electrolyte of a lithium secondary battery according to claim 1, wherein the electrolyte further comprises a swelling-inhibiting additive.

28. The electrolyte of a lithium secondary battery according to claim 27, wherein the swelling-inhibiting additive is selected from the group consisting of propane sultone, bisphenol, dimethylfuran, 1,3-propandiol cyclic sulfate, N-acetylcaprolactam, and a mixture thereof.

29. An electrolyte of a lithium secondary battery comprising lithium salts; an organic solvent with a high boiling point; a carbonate-based additive compound having substituents selected from the group consisting of a halogen, a cyano (CN), and a nitro (NO₂), and an organic sulfone-based compound of formula (3):



wherein R₁ and R₂ are independently selected from the group consisting of a primary, secondary, or tertiary alkyl group, an alkenyl group, an aryl group, and a cycloalkyl group, or R₁ and R₂ are bound together to form a cyclic ring.

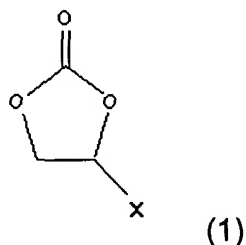
30. The electrolyte of a lithium secondary battery according to claim 29, wherein R₁ and R₂ are independently selected from the group consisting of a C₁ to C₄ alkyl, a C₂ to C₄ alkenyl, a C₆ to C₁₄ aryl, and a C₃ to C₆ cycloalkyl.

31. The electrolyte of a lithium secondary battery according to claim 29, wherein either one of R₁ and R₂ is a vinyl.

32. The electrolyte of a lithium secondary battery according to claim 29, wherein the sulfone-based compound is selected from the group consisting of vinyl sulfone, methyl sulfone, methylvinyl sulfone, ethylvinyl sulfone, phenyl sulfone, phenylvinyl sulfone, chlorophenylvinyl sulfone, fluorophenylvinyl sulfone, benzyl sulfone, tetramethylene sulfone, butadiene sulfone, and a mixture thereof.

33. The electrolyte of a lithium secondary battery according to claim 29, wherein the carbonate-based additive compound is a cyclic carbonate.

34. The electrolyte of a lithium secondary battery according to claim 29 wherein the carbonate-based additive compound is a carbonate represented by formula (1):



wherein X is selected from the group consisting of a halogen, a cyano (CN), and a nitro (NO₂).

35. The electrolyte of a lithium secondary battery according to claim 29 wherein the carbonate-based additive compound is fluoroethylene carbonate.

36. The electrolyte of a lithium secondary battery according to claim 29, wherein the carbonate-based additive compound is added in an amount of 0.01 to 10 wt%.

37. The electrolyte of a lithium secondary battery according to claim 36, wherein the carbonate-based additive compound is added in an amount of 0.01 to 5 wt% based on the total amount of the electrolyte.

38. A lithium secondary battery comprising:
a positive electrode including a material that reversibly intercalates/deintercalates lithium ions, or a material that reversibly forms a lithium-containing compound as a positive active material;

a negative electrode including a lithium metal, a lithium-containing alloy, or a material that reversibly intercalates/deintercalates lithium ions; and

an electrolyte comprising:

lithium salts;

an organic solvent with a high boiling point; and a

carbonate-based additive compound having substituents selected from the group consisting of a halogen, a cyano (CN), and a nitro (NO₂).

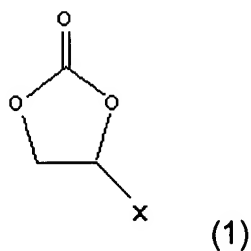
39. The lithium secondary battery according to claim 38, wherein the positive electrode includes a lithium-nickel-based or a lithium-nickel-manganese-based oxide.

40. The lithium secondary battery according to claim 38, wherein the negative electrode includes graphite.

41. The lithium secondary battery according to claim 40, wherein the graphite comprises 1 to 100 wt% of natural graphite.

42. The lithium secondary battery according to claim 38, wherein the lithium secondary battery includes a lithium ion battery or a lithium polymer battery.

43. An electrolyte of a lithium secondary battery comprising:
 a mixed solvent formed by mixing γ -butyrolactone (GBL)/ethylene carbonate (EC)/ethyl methyl carbonate (EMC)/dimethyl carbonate (DMC)/fluorobenzene (FB), LiPF_6 to a concentration of 0.6 to 2.0 M, an ethylene carbonate derivative added in an amount to obtain 0.01 to 10 wt%, based on a total amount of the electrolyte, and fluoroethylene carbonate, wherein the ethylene carbonate derivative includes electron-withdrawing groups with high electronegativity selected from the group consisting of a halogen, a cyano (CN), and a nitro (NO_2), the ethylene carbonate derivative being represented by formula (1):



wherein X is selected from the group consisting of a halogen, a cyano (CN), and a nitro (NO_2).

44. The electrolyte of claim 43, wherein the electrolyte is included in a lithium secondary battery, the lithium battery comprising:

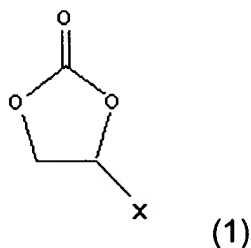
a positive electrode prepared by:

mixing in solvent to prepare a positive material slurry:

a positive active material;

a conductive agent; and
 a binder;
 coating, on a current collector;
 drying;
 compressing; and
 a negative electrode formed by:
 mixing to prepare a negative material slurry:
 a negative active material; and
 a binder;
 coating on a current collector;
 drying; and
 compressing;
 a separator comprising a porous film separator interposed between the positive electrode and the negative electrode,
 wherein the combination of the positive electrode, separator and the negative electrode are wound together and placed in a battery case to form the battery.

45. A method of preparing an electrolyte of a lithium secondary battery, comprising:
 mixing γ -butyrolactone (GBL)/ethylene carbonate (EC)/ethyl methyl carbonate (EMC)/dimethyl carbonate (DMC)/fluorobenzene (FB) to prepare an organic mixed solvent;
 adding LiPF_6 in an amount to form a concentration of 0.6 to 2.0 M LiPF_6 ; and
 adding an ethylene carbonate derivative,
 wherein the ethylene carbonate derivative includes electron-withdrawing groups with high electronegativity selected from the group consisting of a halogen, a cyano (CN), and a nitro (NO_2), the ethylene carbonate derivative being represented by formula (1):



wherein X is selected from the group consisting of a halogen, a cyano (CN), and a nitro (NO_2).

46. A method of preparing a secondary lithium battery, comprising:

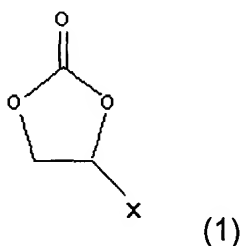
forming an electrolyte by:

mixing γ -butyrolactone (GBL)/ethylene carbonate (EC)/ethyl methyl carbonate (EMC)/dimethyl carbonate (DMC)/fluorobenzene (FB) to prepare an organic mixed solvent;

adding LiPF_6 in an amount to form a concentration of 0.6 to 2.0 M LiPF_6 ;

adding an ethylene carbonate derivative,

wherein the ethylene carbonate derivative includes electron-withdrawing groups with high electronegativity selected from the group consisting of a halogen, a cyano (CN), and a nitro (NO_2), the ethylene carbonate derivative being represented by formula (1):



wherein X is selected from the group consisting of a halogen, a cyano (CN), and a nitro (NO_2);

preparing a positive electrode by:

mixing in solvent to prepare a positive material slurry:

a positive active material;

a conductive agent; and

a binder;

coating the positive material slurry on a current collector to form a first coated foil;

drying the first coated foil;

compressing the first coated foil; and

forming a negative electrode by:

mixing to prepare a negative material slurry:

a negative active material; and

a binder;

coating the negative material slurry on a current collector to form a second coated foil;

drying the second coated foil; and

compressing the second coated foil;

interposing a separator comprising a porous film separator between the positive electrode and the negative electrode,

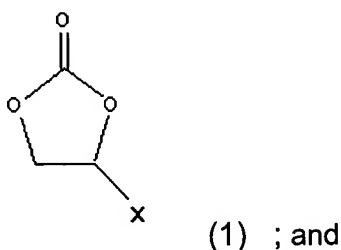
winding the combination of the positive electrode, separator and the negative electrode together to form a wound combination;
 placing the wound combination in a battery case; and
 injecting the electrolyte into the case to form the battery.

47. An electrolyte of a lithium secondary battery comprising:
 a mixture comprising:

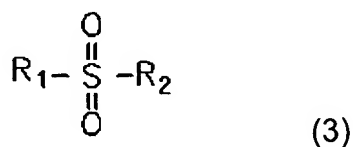
γ -butyrolactone (GBL);

lithium salts;

a carbonate-based additive compound represented by formula (1) wherein X is selected from the group consisting of a halogen, a cyano (CN), and a nitro (NO₂):



an organic sulfone-based compound of formula (3):



wherein R₁ and R₂ are independently selected from the group consisting of a primary, secondary or tertiary alkyl group, an alkenyl group, an aryl group, and a cycloalkyl group, or R₁ and R₂ are bound together to form a cyclic ring.

48. The electrolyte according to claim 47, wherein the carbonate-based additive compound is fluoroethylene carbonate.

49. The electrolyte according to claim 47, wherein the carbonate-based additive compound is added in substantially an amount of 0.01 to 10 wt% based on a total weight of the electrolyte.

50. The electrolyte according to claim 49, wherein the carbonate-based additive compound is added in substantially an amount of 0.01 to 5 wt% based on the total weight of the electrolyte.

51. The electrolyte according to claim 47, wherein the lithium salts are at least one selected from the group consisting of LiPF_6 , LiBF_4 , LiSbF_6 , LiAsF_6 , LiClO_4 , LiCF_3SO_3 , $\text{Li}(\text{CF}_3\text{SO}_2)_2\text{N}$, $\text{LiC}_4\text{F}_9\text{SO}_3$, LiSbF_6 , LiAlO_4 , LiAlCl_4 , $\text{LiN}(\text{C}_x\text{F}_{2x+1}\text{SO}_2)(\text{C}_y\text{F}_{2y+1}\text{SO}_2)$ (where x and y are natural numbers), LiCl , and LiI .

52. The electrolyte according to claim 47, wherein R_1 and R_2 are independently selected from the group consisting of a C_1 to C_4 alkyl, a C_2 to C_4 alkenyl, a C_6 to C_{14} aryl, and a C_3 to C_6 cycloalkyl.

53. The electrolyte according to claim 47, wherein R_1 and R_2 are independently a halogen-substituted alkyl group, an alkenyl group, an aryl group, or a cycloalkyl group.

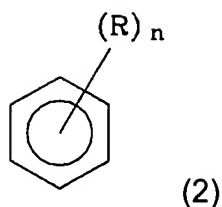
54. The electrolyte according to claim 47, wherein the sulfone-based compound is selected from the group consisting of vinyl sulfone, methyl sulfone, methylvinyl sulfone, ethylvinyl sulfone, phenyl sulfone, phenylvinyl sulfone, chlorophenylvinyl sulfone, fluorophenylvinyl sulfone, benzyl sulfone, tetramethylene sulfone, butadiene sulfone, and a mixture thereof.

55. The electrolyte according to claim 47, wherein the sulfone-based compound is added in substantially an amount of 0.01 to 10 wt% based on the total weight of the electrolyte.

56. The electrolyte according to claim 55, wherein the sulfone-based compound is added in substantially an amount of 0.01 to 6 wt% based on the total amount of the electrolyte.

57. The electrolyte according to claim 51, wherein the lithium salts are used in a concentration ranging from 0.6 to 2.0 M.

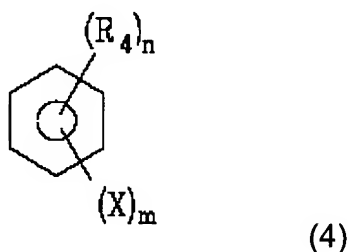
58. The electrolyte according to claim 47, wherein the electrolyte further comprises an aromatic hydrocarbon organic solvent of formula (2):



wherein R is a halogen or a C₁ to C₁₀ alkyl, and n is an integer of 0 to 6.

59. The electrolyte according to claim 58, wherein the aromatic hydrocarbon organic solvent is selected from the group consisting of benzene, fluorobenzene, toluene, fluorotoluene, trifluorotoluene, xylene, and a mixture thereof.

60. The electrolyte according to claim 47, wherein the electrolyte further comprises a compound of formula (4):



wherein R₄ is a C₁ to C₁₀ alkyl, a C₁ to C₁₀ alkoxy, or a C₆ to C₁₀ aryl, X is a halogen, and m and n are integers ranging from 1 to 5, where m+n is less than or equal to 6.

61. The electrolyte according to claim 60, wherein the compound of formula (4) is a compound selected from the group consisting of 3-fluoroanisole, 3-chloroanisole, 3-bromoanisole, 4-fluoroanisole, 4-chloroanisole, 4-bromoanisole, 2,4-difluoroanisole, 3,5-difluoroanisole, 3-chloro-5-fluoroanisole, and a mixture thereof.

62. The electrolyte according to claim 60, wherein the compound of formula (4) is added in substantially an amount of 0.01 to 10 wt% based on the total amount of the electrolyte.

63. The electrolyte according to claim 62, wherein the compound of formula (4) is added in substantially an amount of 0.01 to 6 wt% based on the total amount of the electrolyte.